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Laparoscopic Assisted Splenectomy in Dogs: Introducing the Intracorporeal Ligature Placement Technique

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Abstract

Objective- To assess the feasibility of splenectomy using intracorporeal ligature placement technique.
Design- Randomized experimental study.
Animals- Dogs (n=7) weighting≥ 20 kg.
Procedures- Dogs were randomly selected. A lap-assisted splenectomy was performed. The feasibility of splenectomy was examined using intracorporeal ligatures. Comparisons were made regarding the anesthesia, surgery and splenectomy time. Moreover, oxygen saturation, end tidal CO2, heart rate respiratory rate and rectal temperature were recorded and compared. Descriptive analyses were used.
Results- Mean durations were as follows: 114 min for anesthesia (range 80-210), 48 min for splenectomy (range 27-100 min) and 74.31 min for surgery (45-140 min). Mean RR for all 7 dogs was 16 per/min (PM) .The maximum was 29 PM and the minimum 8 PM. Mean HR was 66 beats per minute (BPM) .The maximum was 129 BPM and the minimum 38 BPM. Mean SPO2 was 96.2% for all 7 dogs. Minimum and maximum SPO2 levels were 84% and 99% respectively. The lowest and highest temperatures were 96.8 and 99.7 ° F during the procedure. Mean temperature was reported to be 97.9° F. Mean ETCO2 was 38.2. Minimum and maximum levels were 29 And 43 Respectively.
Conclusion and Clinical Relevance- lap-assisted splenectomy could be safely performed using intracorporeal ligature. It is a safe technique which provides solid vessel sealing.
Key Words- Laparoscopy, Splenectomy, Dog.

Introduction

Modern minimally invasive surgery (MIS) was first introduced to veterinary medicine at the end of 20th century. Since then, it has improved and is now in its most advanced era. Today MIS in human medicine is not only considered an alternative to conventional invasive surgical techniques, but also a gold standard in many surgical procedures.[1-2] In small animal surgery, various procedures such as adrenalectomy, gastropexy and ovariohysterectomy are now being conducted laparoscopically.[3-5] Since laparoscopy is advantageous techniques and proved to be superior than conventional open techniques in many aspects, surgeons worldwide, are encouraged to perform procedures, laparoscopically.[6-9]

Splenectomy is a procedure that is commonly performed in dogs with splenic tumors or hemoabdomen.[10] It is also done in blood donor dogs as an elective surgery to prevent possible hemobartonella infection.[8] Laparoscopic assisted (LA) Splenectomy is replacing the old fashioned open splenectomy method. Advantages of laparoscopic splenectomy included less invasiveness, less morbidity, less post-operative pain, less hospitalization time and decreased narcotic use.[10-12]Although reports of LA splenectomy are available, this is considered the first report of intracorporeal ligature placement.

Therefore the objectives of this study were to evaluate the feasibility of laparoscopic intracorporeal ligature placement in dogs.

Materials and Methods

This study was a prospective, single center, experimental study. The experiment was performed on 7

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mixed breed, young adult female healthy dogs weighing 20.0±2.1 kg. The study was performed at the biomedical research center, Faculty of Veterinary Medicine, University of Tehran. The dogs were vaccinated; anti parasite drugs were given and had free access to water.
Suture material (Silk number 2-0 Ethicon, USA) was used to place intracorporeal double ligatures around splenic vessels and then the splenic vessels were cut, using laparoscopic Metzenbaum scissors (Karl Storz Endoscopy, Goleta, CA).
Rectal temperature, Respiratory rate and Heart rate of each dog were recorded before induction and during anesthesia.
All dogs were examined clinically and their blood was collected for a complete blood count and serum biochemical profile testing. Oral feeding was restricted for 12 hours prior to induction of anesthesia. Premedication was conducted using intramuscular (IM) administration of Acepromazine (0.1 mg/kg) and Morphine (0.01 mg/kg). After 15-30 minutes (min), the right cephalic vein was catheterized. Anesthesia was induced, by intravascular injection of Ketamine (5.5 mg/kg) and Diazepam (0.1 mg/kg). Endotracheal tube was then placed and the anesthesia was continued by inhalation of Isofluran (1-5 %) in oxygen. Cefazolin (22 mg/kg IV) was injected, 30 min prior to surgery and continued every 90 min during the procedure. Lactated ringer's was administered (10 ml/ kg/h IV). Meloxicam (0.1 mg/kg IV) was used as a prophylactic analgesic and Tramadol (1 mg/kg IM) was used to manage postoperative pain and discontinued 48 hours following surgery.

Surgical procedure

All procedures were performed by a single skilled surgeon. Each dog was restrained on the surgery table in a dorsal position with the head tilted 30 degrees to the right. The aseptic preparation of the abdominal area was performed.
All surgeries were performed using the laparoscopic assisted (LA) technique, meaning that after performing laparoscopic splenectomy, umbilical port incision site was enlarged to about 5 cm and the freed spleen grasped with Doyen forceps and removed from the body. Then, the incision site was sutured in 3 layers, using the routine manner. Dogs were monitored during recovery and then returned to their pens. The entire laparoscopy procedure was video recorded for each dog. Each laparoscopic splenectomy procedure was performed using a standard 3-portal laparoscopy technique.
First, a 5 mm ventral midline skin incision was made in an umbilical location, using number 15 scalpel blade. Two towel clamps were placed on both sides of the incision. The Veress needle was introduced into the abdominal cavity. The abdominal cavity was then insufflated with low flow CO_2 (2 liter/min) until the pressure reached 12 mmHg. After filling the abdomen with CO_2, Veress needle was removed and a 5 mm sharp-round trocar-cannula assembly (Carl Storz endoscopy) was introduce into the abdominal cavity. Laparoscopic 30 degree (29 cm, Carl Storz endoscopy) lens camera was introduced into the abdominal cavity through the umbilical port. The entire abdominal cavity was explored to note any problem before introducing the other ports. Then, cranial and caudal poles of spleen were scoped to decide on the perfect approach for placing the other ports which provide the best exposure and access to the spleen. Two other 5 mm skin incisions were made in the following regions. A 2nd port 5 cm caudal and the 3rd port 5 cm cranial to the umbilical port (1st port) were inserted. These ports were introduced into the abdominal cavity (one at a time) under monitoring of the laparoscope. Extreme caution was exercised to avoid rupturing spleen or any other organ inside the abdominal cavity during the procedure (Fig.1).

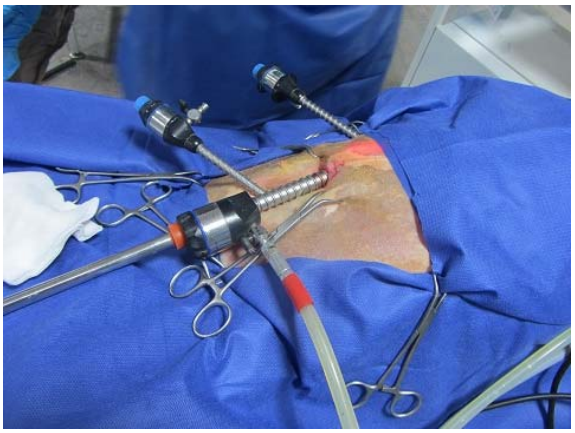

Figure 1- The port placement.

A Maryland forceps (Carl Storz endoscopy) was introduced to the abdomen from port 2 (or 3) to evaluate the spleen and its position. Then, the other port was used to introduce the suture material. Intracorporeal suture ligation was used. After placing the ports, a laparoscopic needle holder and a curved atraumatic Maryland dissecting forceps (Carl Storz endoscopy) were used. Number 2-0 Silk suture material (Ethicon) was cut short (~ 15 cm) and introduced to the abdominal cavity by a needle holder. At first, the 5 mm Maryland forceps was used to bluntly dissect the splenic vessels free of their surrounding tissue. Then, the needle holder was used to place ligatures around splenic vessels. At least 1 cm space was left between double ligatures on each vessel (Fig. 2).
Some approximating vessels were ligatured in a single bite because of their proximity. After all ligatures were placed, a laparoscopic Metzenbaum scissors was introduced through the 2nd port and the vessels were cut in the 1 cm space between the double ligatures (Fig. 3).

Caution was exercised to place the distal ligature as distal as possible to the spleen and the proximal ones, 1 cm proximal to the distal ligature. On average, 5 or 6 ligatures (10 or 12 double ligatures total) were placed for each dog in this group.
All splenic vessels were double ligated in the same way that the conventional open splenectomy is performed.[18] The other port sites were also sutured in 2 separate layers with the same suture material.

Post-operative management

Dogs were closely monitored for 1 hour after recovery from anesthesia (mucous membranes and CRT were checked). They were then put in their pens and Tramadol (1 mg/kg IM) was injected.
Dogs had free access to water as soon as they were put in their pens. Each dog was checked at least twice a day and vital signs were recorded for a week post-op.

Measured parameters

Duration of the entire surgery, anesthesia, and splenic vessel ligation and excision were recorded. Moreover, intra-operative complications such as considerable hemorrhage, and clinical parameters, including heart rate/min, respiratory rate/min, levels of oxygen saturation, rectal temperature and end tidal carbon dioxide, were recorded as well.
Duration of surgery (min): the time from finishing port placement to the time when the abdominal incision was enlarged.
Duration of splenectomy (min): the time from inserting the Maryland forceps to the time when spleen was excised free.
Duration of anesthesia (min): time from induction of anesthesia to complete recovery.

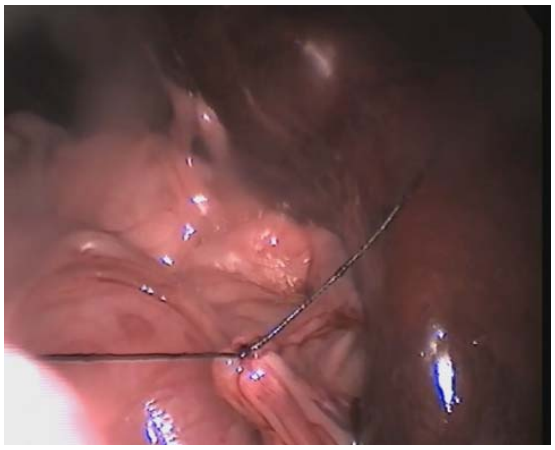

Figure 2- intracorporeal ligatures placement.

Statistical analysis

All dogs were included in the statistical analysis no matter how they did in surgery (unless they were expired, which did not occur). Descriptive statistics was used to analyze the data. Since normality test was performed and it showed that the data is distributed normally, parametric data analysis was conducted. A confidence interval of 95% was reported along with the minimum, maximum and mean. All analyses were performed in the SPSS software version 22.

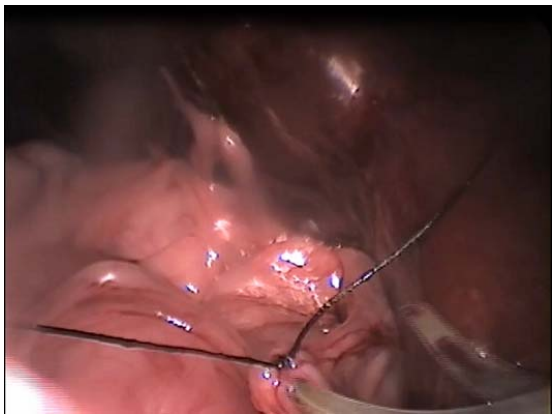

Figure 3- cutting the ligatures with laparoscopic scissors

Results

Successful LA splenectomy was performed in 7 mixed breed dogs without any major intra- or post-operative complication. All surgeries were completed successfully and intra-operative hemorrhage was minimal, so there was no need to stop the procedure and convert to an open approach.
Mean surgical time for all the dogs was 74 min (range, 45- 140 min with 95% of confidence interval). Splenectomy time for all dogs was recorded. Splenic ligation and excision time (SLET) was also recorded individually for each dog. Mean SLET was 48 min with the shortest taking 27 min and the longest 100 min. The duration of anesthesia was recorded as well. For all 7 dogs, mean anesthesia time was measured 114 min (minimum 80 and maximum 210 min). The results are summarized in Table 1.
The respiratory rate/min during anesthesia was recorded for all dogs undergoing surgery. Mean respiratory rate/min for all 7 dogs was 16 per/min (PM) .The maximum was 29PM and the minimum 8 PM with 9.3 SD.The heart rate/min during anesthesia was also recorded. For all dogs undergoing surgery, mean heart rate/min was 66 beats per minute (BPM) .The maximum was 129 BPM and the minimum 38 BPM.
Mean SPO_2 was 96.2%. Minimum and maximum SPO_2 levels were 84% and 99% respectively.

Temperature was ranged between 103.4 and 96.8° F, (39.9 and 36 ˚C respectively), in all dogs mean was 99.8° F (37.6 ˚C).

Mean end tidal Carbon dioxide level was 38.2. Minimum and maximum levels were 29 And 43 Respectively.

These results are included in Table 2.

Table 1- Minimum, maximum and mean Durations of surgery, splenectomy and anesthesia with 95% of confidence interval

	Surgery	Splenectomy	Anesthesia
Minimum(min)	45	27	80
Maximum (min)	140	100	210
Mean(min)	74	48	114

Table 2- Table 2. Minimum, maximum and mean respiratory rate, heart rate, rectal temperature, end tidal Carbon dioxide and Oxygen saturation level

	Mean	Minimum	Maximum
RR (PM)	16	8	29
HR (BPM)	66	38	129
SPO_2 (%)	96.2	84	99
Temperature (˚C)	37.6	36	39.9
$ETCO_2$	38.2	29	43

Discussion

We supported the hypothesis that LA splenectomy is feasible by means of ligating splenic vessels with suture material, using laparoscopic needle holders. To the author's knowledge, this finding has never been reported in veterinary literature before.

Although LA splenectomy has been reported using an ultrasonic harmonic scalpel device [13], our study remains the only one that proves feasibility of LA intracorporeal ligature placement splenectomy (to the author's knowledge). Khalaj et al. have reported comparing multiport LA splenectomy with single incision laparoscopic splenectomy (SILS) in dogs. They have used harmonic scalpel device in both methods. They concluded that SILS is less time consuming than multiple port laparoscopy. Collard et al have reported a laparoscopic assisted treatment of splenic hemangiosarcoma in a dog with Ligasure.[14] They concluded that Ligasure is time-saving in this procedure.

Although our port placements did a perfect job in approaching the spleen, it was sometimes necessary to change the portals of the scope with instruments to enhance visualization and maintain ergonomy. This has been reported in other studies as well[12,13] and is somehow time-consuming. It could be considered as a minor complication of laparoscopic splenectomy.

All intracorporeal ligatures provided safe hemostasis and vessel sealing. Although other methods of laparoscopic splenectomy require expensive instruments, intracorporeal ligature placement only required simple suture material and a laparoscopic needle holder. Like other LA procedures, this technique requires a full thickness abdominal incision. This full thickness incision could be referred to as a minor disadvantage of LA splenectomy. Other studies have also reported this.[3, 12, 17] we supported the hypothesis that a 5 cm incision is sufficient to remove the spleen. Our results are in agreement with the results of Collard et. al.[14]

Intra operative hemorrhage was minimal in our study. Our results agree with the results of others.[11,12, 14]

Another complication that interfered with port placement and the procedure itself was the presence of falciform fat. Although others have reported this complication in different laparoscopic procedures[12] the presence of falciform fat in splenectomy raises major difficulties for the surgery team. We had to retract and change the ports of the scope and instruments several times during a procedure, because falciform fat was obstructing the view. Many surgeons have recommended excising the falciform fat when performing open laparotomy procedures.[18] Collard et.al have used different port location and have not mentioned any falciform fat interference.[14]

In order to remove the spleen easily from a 5 cm incision, the surgeon should locate the cranial pole of the excised spleen and grab it with a long Doyen forceps. Extreme care should be exercised not to rupture the thin capsule of the spleen. Accidental rupturing of the capsule may result in considerable hemorrhage (from the retained blood in the excised spleen). This complication has been reported by Khalajet. al.[13]

Double ligating each splenic vessel separately is not reasonable. It is extremely time-consuming and also difficult. That is why we only placed 5 or at most 6 pairs of ligatures on all the splenic vessels (10-12 ligatures

total). In this study, intracorporeal ligature placement seemed sufficient to provide proper hemostasis. Unlike the study by Zhang et al.,on goats, it seems that there is no need to use hemoclips for splenectomy in dogs. Using hemoclips would add to the duration and expenses of the procedure. Learning to place intracorporeal sutures and ligatures is a challenge for veterinary surgeons. Although it has been widely practiced for years in humans, [14] this study is one of the few veterinary studies reporting Intracorporeal ligature placement. Others have reported successful placement of intracorporeal sutures in veterinary surgery[12, 19, 20] but to the author's knowledge, this is the first report of laparoscopic intracorporeal ligature placement in dogs. The authors believe that it is necessary for the veterinary endosurgeon to acquire sufficient learning curve in placing intracorporeal sutures. There are various ways to accomplish this, such as practicing on cadavers and using simulators.[21,22] Mild, self-limiting hemorrhage may occur during blunt dissection which did not require any method of hemostasis in our study. Another important factor is the length of the introduced suture material. The suture material should neither be too short (one may need to reintroduce more suture material to place more ligatures) nor too long (would make suturing extremely difficult). Although in our study in most cases it was necessary to reintroduce more length of suture material, the surgeon preferred not to use sutures longer than 15 cm in the first place, since handling and maneuverability may have become cumbersome.

Intracorporeal ligature placement was time consuming regarding the duration of splenectomy, surgery, and anesthesia. We therefore, hypothesize that although LA splenectomy is feasible by means of placing intracorporeal ligatures, it is time-consuming even for experienced surgeons. The only advantage of intracorporeal suturing was its lower cost.

Several limiting factors affected this study. Small numbers of dogs were recruited for this prospective study which decreases the validity of the results. Because the procedure was performed on the healthy spleen, the feasibility of the technique should be examined in diseased spleens like tumors and torsions as well.

In conclusion, laparoscopic assisted splenectomy is feasible by means of placing ligatures intracorporeally. It is an effective, safe, and trustable method for vessel sealing.

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چکیده

برداشت طحال به کمک لاپاروسکوپی در سگ: معرفی روش کارگذاری لیگاتورهای داخل صفاقی

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هدف- اثبات امکان پذیری انجام جراحی لاپاروسکوپی برداشت طحال در سگ به کمک قرار دادن لیگاتور روی عروق طحال به شیوه‌ی لاپاروسکوپی.

طرح- مطالعه تجربی

حیوانات- ۲۰ قلّاده سگ با وزن بیشتر از ۲۰ کیلوگرم.

روش‌کار- سگ ها به صورت اتفاقی از یک نمونه بزرگ انتخاب شدند. جراحی لاپاروسکوپی برداشت طحال روی آنها انجام شد. امکان پذیری روش قرار دادن لیگاتور روی عروق طحال با روش لاپاروسکوپی مورد آزمایش قرار گرفت. پارامترهای مختلفی تحت بیهوشی مورد بررسی قرار گرفتند از جمله: طول مدت بیهوشی، جراحی، برداشت طحال. علاوه بر اینها درصد اشباع اکسیژن، میزان دی اکسید کربن باز دمی، ضربان قلب و تعداد تنفس هم مورد اندازه گیری قرار گرفتند. از آمار توصیفی برای مقایسه ها استفاده شد.

نتایج- میانگین طول مدت بیهوشی ۱۱۴ دقیقه (۸۰-۱۲۰ دقیقه)، میانگین طول مدت برداشت طحال ۴۸ دقیقه (۲۷-۱۰۰ دقیقه)، و میانگین طول زمان جراحی ۷۴/۳۱ دقیقه (۴۵-۱۴۰ دقیقه) بود. میانگین تعداد تنفس ۱۶ بار در دقیقه (۸-۲۹ بار در دقیقه)، میانگین تعداد ضربان قلب ۶۶ بار در دقیقه (۳۸-۱۲۹ بار در دقیقه). میانگین درصد اشباع اکسیژن ۹۶/۲٪ (۸۴-۹۹٪). میانگین دمای رکتال۳۷/۴ (۳۶,۱-۳۸,۹)، میانگین دی اکسید کربن باز دمی ۳۸/۲ (۲۹-۴۳) بود.

نتیجه‌گیری و کاربرد بالینی- جراحی برداشت لاپاروسکوپی طحال در سگ با روش قرار دادن لیگاتور به صورت لاپاروسکوپی روی عروق طحال امکان‌پذیر می‌باشد. لیگاتورهایی که به این روش روی عروق قرار داده می‌شوند توانایی خون بندی کافی را دارا بوده و یک روش امن برای جراحی برداشت طحال می‌باشد.

کلمات کلیدی- لاپاروسکوپی، برداشت طحال، سگ.